TEMIC Semiconductors

TEMIC is the microelectronics enterprise of Daimler-Benz. TEMIC's Semiconductor division is a leading manufacturer of application-specific, value-adding integrated circuits for communication equipment, automotive and industrial systems, computers and broadcast media. Discrete semiconductors and optoelectronic devices make the product range complete.

With a technology portfolio which includes bipolar, BiCMOS, CMOS and DMOS processes, TEMIC Semiconductors provides a unique set of components and solutions.

DVD

DVD first stood for **D**igital **V**ideo **D**isk because the first applications appeared in the video domain. Very soon, however, it was clear that also data storage applications would become very important. Therefore, DVD now means **D**igital **V**ersatile **D**isk.

DVD will soon possibly replace the magnetic floppy drives when the following requirements are met by DVD:

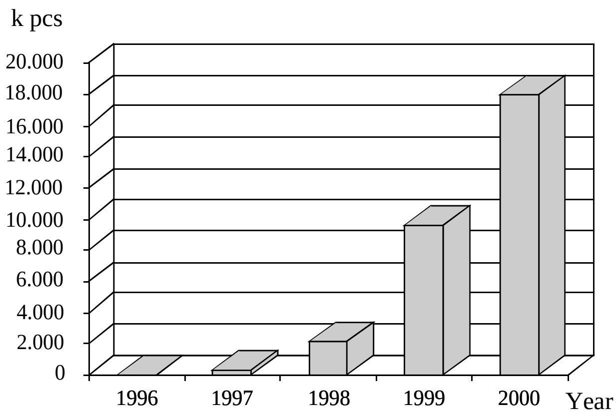
- Worldwide standard
- High on-line capacity
- Low costs
- High reliability
- One drive for various disk formats
- Down-compatible with existing CDs
- Up-compatible with future DVDs

To make this revolution happen, two multi-billion dollar consortia strived for a technical solution. And in autumn of 1995, the two consortiums – one led by Toshiba and backed by media giants such as Time Warner, the other under the leadership of Sony/Philips – announced two different solutions for a future-oriented digital video and multimedia disk. Neither side wanted the kind of wasteful battle which accompanied the introduction of the video cassette, so they decided to join forces and produce a common standard for DVD (will be available as ROM and RAM) which unites the advantages of their two technologies.

The new standard will be applied worldwide. The disk is 120 mm in diameter, just like the standard audio CD. At 650 nm, the laser wavelength is somewhat shorter. The capacity of a single-layer DVD ROM is 4.7 Gbytes. With 2.6 Gbytes with one layer on one side, the re-writeable DVD RAM holds four times more information than a conventional CD ROM.

A range of storage capacities is possible, depending on whether the DVD has one or two layers for data storage per side, and if the DVD is coated on one side or both sides. The forthcoming high-end version of the video DVD ROM will hold more than 17 Gbytes.

The new standard and the phase-change technology developed have brought us closer to the re-writeable DVD RAM, with its storage capacity of 2.6 Gbytes per side. This development comes at exactly the right time for the multimedia age: the world market for the old and new-style CD storage drives is expected to have reached around 60 million by the year 2000. Forecasters are also predicting a fast-growing market for DVD RAM drives.

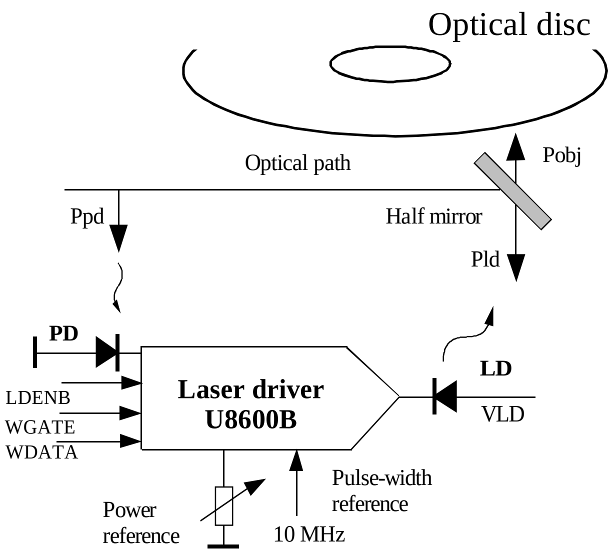


DVD market

Additional advantages of the new standard are very practical ones. For the consumer, the DVD drives of the future will be capable of reading today's audio CDs for example. Manufacturers of DVDs can use most equipment and technology available today to produce the new DVDs.

How DVD Works

The emitted laser light is controlled by a servo loop comprising of a laser, parts of the optical path, photo diode and amplifier. Using a servo system is a very efficient method to precisely generate the write pulse shapes required for the high recording density. The low laser power read mode is also adjusted by the controller. The read path, which uses a further photo diode and a read amplifier, is not shown.

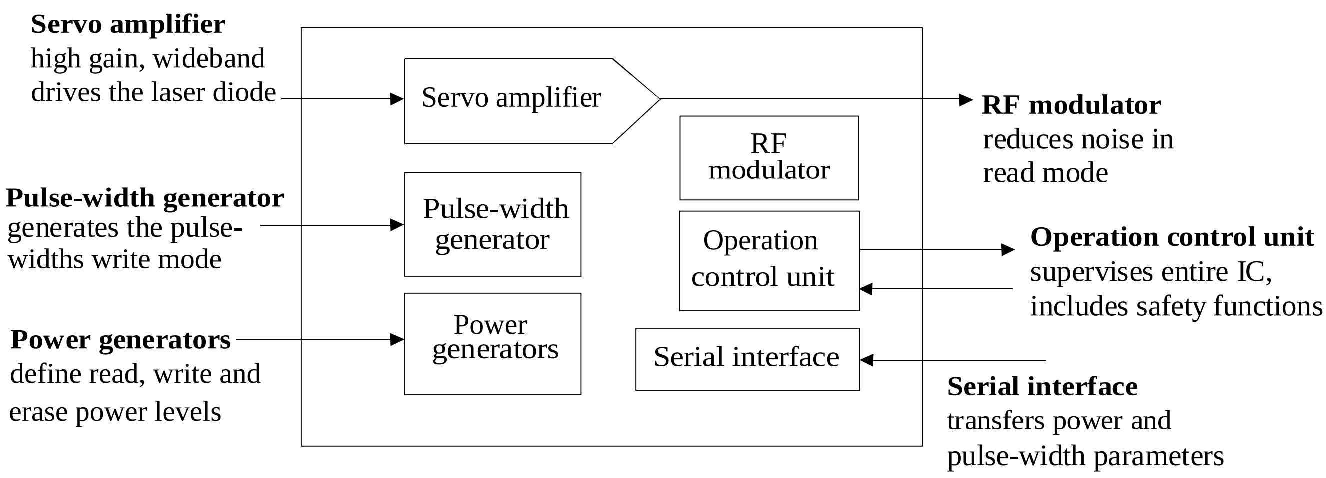


Application of the DVD laser driver

The phase-change principle makes use of the characteristics of Germanium Antimony Tellurium layers: heat changes the layer's state from amorphous- to single crystal. The various temperatures required for this process are generated by laser light of varying intensity. When the phase of the material changes, the transparency for the laser beam in read mode of the optical layer also changes. If a reflective surface is placed behind the thin Germanium Antimony Tellurium layer, data can be read using low-intensity light and written directly using high-energy laser light. A significant advantage of this method compared to the **M**agneto-**O**ptical (MO) principle is that in the latter, time-consuming magnetic deletion is necessary before re-writing the disk.

The modulation process in the new technology is characterized by a very high writing density. Data are written with a pulse-width modulation process in which the number of zeros following a one are encoded. This process produces a density of approximately 0.25 micrometers per data bit, i.e., a data bit is half as long as the wavelength of the laser light.

Reliability and data security are vital for multi-media and computer applications using the new DVD RAM drives. The process of controlling the laser while it reads, writes and erases is of great importance. TEMIC has developed an IC which performs this task perfectly. The U8600B laser controller incorporates an extremely wide-band servo amplifier for controlling the laser power according to the reference pulse height and width generators. The integrated circuit also provides important control and monitoring functions.



Main blocks of the U8600B

The U8600B Laser Driver

The U8600B incorporates all the necessary functional modules in one silicon unit: a broadband servo amplifier, an RF modulator, a pulse-length generator, a digital bus interface and a control unit.

The broadband servo amplifier (bandwidth: 100 MHz) forms the core of the U8600B. It drives the laser diode directly with a DC current amplification of up to 110 dB and a max. laser current of 200 mA. The current is characterized by extremely short rise and fall times.

The servo amplifier drives the laser diode of the optical disc system according to the reference current, I_{ref}. The feedback loop is closed by the optical path and the photo diode which monitors the actual laser power.

The comparison of the photo current and reference current, I_{ref}, is performed within the first amplifier stage. This stage is realized as a differential transimpedance amplifier, yielding low input impedance, biasing voltage for the operation of the grounded photo diode, differential voltage outputs, and an error signal output for the servo-loop monitor.

The total closed loop gain (amplifier gain + laser efficiency + optical path attenuation + photo diode sensitivity) is controlled at the GADJ pin of the second amplifier stage. Depending on tolerances of the optical parameters, the closed loop gain is adjusted by a control voltage (referred to V_{REF}) to obtain good loop stability and pulse shape. The total attenuation i(PDK)/i(LDK) is in the order of 40 dB.

The high-gain amplifier is responsible for the high DC gain (approx. 110 dB) and the first pole frequency ($f_1 \approx 60$ kHz) of the servo amplifier. To satisfy the needs for high gain and high bandwidth, a parallel amplifier technique with an additional wideband path, and a summing amplifier is used. A control input FSC facilitates the correct adjustment of the frequency response slopes of the two contributing amplifiers.

The pole frequency of the wideband path ($f_2 \approx$ 10 MHz) is realized in the following amplifier stage, where the differential to single-ended conversion required for the laser driver stage is performed. Furthermore, the laser diode's switch-off is implemented by the "LD off" signal. The CC pin is a direct connection to the integrated low-pass filter, useable for possible manipulations of the frequency response.

The laser driver stage is capable of driving up to 200 mA. The current limiter is integrated within this function block, generating a "current limit" signal for the operation control unit, slightly below the limiting condition.

A **R**adio-**F**requency **M**odulator (RFM) is integrated on the chip to reduce laser-mode hopping noise caused by weak modulation during read mode.

The RFM consists of a voltage-controlled oscillator and a laser driver stage. The VCO frequency is controlled at around 300 MHz by the voltage VDC, generated within the delay-adjust circuit. The current swing of the laser driver stage is externally adjusted at the HFV pin (max. swing 5 mA).

Integrated DA converters provide various power levels for the three laser-diode functions reading, erasing and writing. Write- and Off-pulses are generated by two pulse-length generators. Read, erase, and write levels are generated by three D/A converters which each have a 4-bit resolution. According to the optical efficiency, their reference currents are set by the external resistor. The read current continuously contributes to the total current, whereas the erase and write current are switched according to the "off-pulse width" and "write-pulse width" signals from the pulse-width generators. Furthermore, a modulation current can be added externally at the EXTM pin. The buffer/monitor block splits the total current into the reference current for the servo loop, the monitor current at the VMON pin, and the threshold current for the servo loop monitor.

A three-wire bus digitally controls the power- and pulse-width parameters.

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Additional monitoring and safety functions are integrated into the unit to prevent damage to the laser and potential data loss.

The main features of the U8600B are as follows:

- Single + 5 V power supply
- Data transfer rates up to 16 Mb/s
- Noise reduction by servo loop and weak high-frequency modulation
- On-chip generation of power levels for read, erase, and write operation
- On-chip generation of write- and off-pulse widths: 15 ns to 90 ns in 5-ns steps
- Digital control of power and pulse parameters via serial 3-wire interface
- Basic power level adjustable
- Monitoring of power supply, laser current and laser power
- Laser shutdown to prevent laser damage and data loss

The U8600B shows TEMIC's technical capability. Customers can test the functionality of the various blocks using the device and its demo board. The functional modules of the IC (see "Main Blocks of the U8600B") can be configured to customer requirements by creating an ASIC (**A**pplication-**S**pecific **IC**). TEMIC can also provide the servo amplifier as a stand-alone device.

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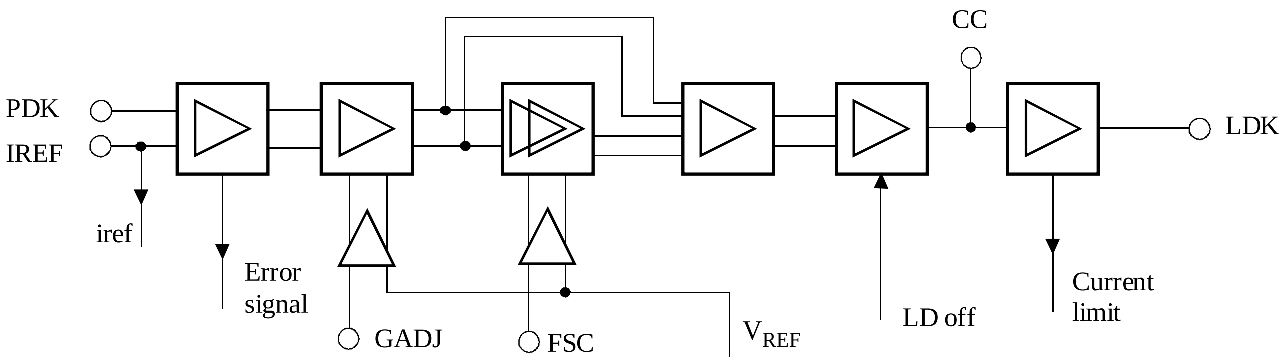
The Heart of the IC: The Servo Amplifier



Key Features of the Servo Amplifier

- Parallel amplifier technique
- High DC gain: 110 dB
- High bandwidth: 100 MHz
- Max. 200 mA laser current
- High slew rate: 5 ns rise/fall time
- Servo gain adjustable